The Role of Informational Medium on Decisions to Respond to a Message

By

Mohammad Ali Salehinejad

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Chairperson: Dr. Paul Atchley

Dr. Derek Reed

Dr. RuthAnn Atchley

Dr. Bruce Liese

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The Thesis Committee for Mohammad Ali Salehinejad certifies

that this is the approved version of the following thesis:

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Chairperson Dr. Paul Atchley

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Abstract

The dangers of texting while driving has been clearly reported in distracted driving studies. People generally see texting while driving a dangerous behavior but they do it. A new line of research in the area of driving distraction is concerned with why people do risky behavior such as texting while driving although most people believe it is a dangerous behavior. This study examined the value of responding to a message and factors that may influence the decision making process of people about responding to message. Using the delay discounting method in this study it was examined if information medium of message influences decisions to respond to a message. The results of first experiment showed that there is a quantitatively difference in the shape of the delay discounting function for different informational mediums suggesting discounting for a cell phone text message compared with post-it message and post card message. The results of the second experiment showed the same different shape of delay discounting function for the value of responding to a message depending on the weather condition and response medium of a message in driving condition. People could not wait to respond to a message while driving in a normal weather condition. They also showed inability to wait to respond to a message if it is received through a car in-dash system rather than cellphone. In sum this study showed that people's decisions to respond to a message is valued differently given informational medium related factors.

Table of Contents

List of Figures

List of Tables

List of Appendices

Introduction

Driver distraction as a result of secondary in-vehicle activities is increasingly known as a significant source of injuries and fatalities on the roadway (Strayer et al., 2013). Using a cellular phone while driving is among top secondary in-vehicle activities especially in young people (Lenhart, Ling, Campbell, & Purcell, 2010). The National Safety Council estimates about 28% of all automobile crashes are due to using cellular phones or texting while driving (National Safety Council, 2010). In a recent survey over 95% of young drivers reported they text while driving. (Atchley, Atwood, & Boulton, 2011). The dangers of texting while driving have been clearly reported in distracted driving studies. A fairly recent meta-analysis about dangerous effects of texting on driving behavior showed that texting poses significant threat to the drivers (Caird, Johnston, Willness, Asbridge, & Steel, 2014). Texting while driving is supposed to be 5-6 times as dangerous as drunk driving (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). Younger drivers report that they know texting while driving is a risky behavior (Atchley et al., 2011) however, they tend to engage in texting while driving (Atchley & Warden, 2012)

Researchers, safety organizations and “policy-making” organizations tried for years to investigate how secondary in-vehicle activities can lead to driving distraction to support legal bans for using cellular phone while driving. The concerns over using a cellular phone are growing and new-emerged concerns tend to address why people need to use cell phone while driving although they know possible threats instead of how such behavior results is risky behavior? (e.g., Atchley and Warden, 2012). What factors make people use their cell-phone while driving although they know it is dangerous? A recent session at the largest traffic safety conference in the U.S. titled “Our Need to Stay Connected: What Challenges Does This Present to the Traffic Safety

Community?" acknowledges the concerns of traffic safety experts regarding this issue (Atchley, Greenfield, & Schick, 2012).

The researches over distracted driving began with questions asking whether using cell-phone while driving does actually impair driving behavior or not and if so how? Results of such studies strongly suggested that using cell-phone while driving does impair driving performance (Strayer, Cooper, & Drews, 2011; Strayer & Drews, 2007; Strayer & Johnston, 2001). This line of research has provided a large amount of compelling findings about how driving behavior could be negatively affected by cell-phone use while driving and how distracted driving occurs in term of visual distraction (Strayer, Cooper, & Drews, 2004), manual distraction and cognitive distraction (Strayer, Watson, & Drews, 2011).

Moreover, even if we know how cell-phone use could impair driving behavior we still need to know why people tend to engage in such dangerous behavior. What other factors influence distracted driving behavior? Recent researches showed that younger drivers who overuse their phone, experience anticipation of messages from their phones frequently and have emotional attachment to their phones and this compulsive use of cell-phone is suggested to be associated with increased crash risk (O'Connor et al., 2013). Texting has become "the preferred channel of basic communication between teens and their friends and cell calling is a close second" (Lenhart et al., 2010; Subrahmanyam & Greenfield, 2008). It is "exploding" among teenagers and the frequency of use of texting has now overtaken the frequency of every other common form of interaction with their friends such as cell phone conversation, social media networks or face-to-face meetings (Lenhart et al., 2010).

A new line of research emerging in recent years is concerned with why people do such risky behavior (e.g., Atchley & Warden, 2012). Taking this approach into account a risky behavior such as texting while driving is suggested to be seen as a behavior with addiction-like nature (Igarashi, Motoyoshi, Takai, & Yoshida, 2005), social dependency (Atchley & Warden, 2012) and impulsiveness (O'Connor et al., 2013) or be associated with some personality variables that are correlated with addictive tendencies (Ehrenberg, Juckes, White, & Walsh, 2008).

Using terms such as addiction (Igarashi et al., 2005), impulsiveness and compulsiveness (O'Connor et al., 2013) may be interesting to media or policy makers but from experimental standpoint we need to investigate whether texting or calling while driving is a sort of addicted and impulsive behavior or it is a simple social activity that can be stopped when it is inappropriate (Atchley & Warden, 2012). To do so we need to investigate impulsive / addictive nature of texting behavior while driving. Impulsive behavior is usually studied in a clinical context using DSM-IV[1] (American Psychiatric Association, 1994) criteria for impulsive behavior. According to this clinical approach, impulsive behavior is defined by tolerance, withdrawal, desire to reduce the behavior and unsuccessful efforts to do so, long time spent on the behavior, engaging in the behavior given negative consequences and longtime of engagement in such behavior (American Psychiatric Association, 1994). Studies with such approach showed that between 6% to 11% of younger adults are addicted to texting which means they showed behaviors related to tolerance, withdrawal, displacement of attention to school or work, and the inability to diminish use (Perry & Lee, 2007).

Although this clinical approach helps us realize epidemiological aspects of addictive texting while driving but it does not allow us to investigate underlying behavioral-cognitive mechanisms of texting behavior while driving in young adults. One way we could study such behavior is from decision making standpoint. In other words rather than focusing on whether the

[1] . Diagnostic and Statistical Manual for Mental Disorders

behavior is "addictive" in nature, it might be more useful to understand the underlying dynamics of the decision making process that make younger adults feeling they "need to text now" (Atchley et al., 2011). The "decision-making model" proposed by Janis and Mann (1997) is a model that is extensively used for studying impulsivity-related behavior such as drinking (Migneault, Pallonen, & Velicer, 1997), smoking (Velicer, DiClemente, Prochaska, & Brandenburg, 1985) and other problematic behaviors (Prochaska et al., 1994). According to this model people weight and evaluate their behavior based on "decisional balance". Decisional balance is a construct that involves cognitive and motivational aspects of human decision making behavior (Velicer et al., 1985). This construct consists of two main components that measure the subjective weighting of the importance of a set of positive (pros) and negative (cons) aspects of engaging in a behavior (Migneault et al., 1997). From "decisional balance" point of view we can evaluate positive and negative aspects of risky texting behavior and then decide to involve in such behavior or not.

Decisional balance takes into account cognitive and motivational aspects of decision-making behavior but we can also take into account behavioral aspect of decision-making behavior. One behavioral approach based on decision making paradigm that helps us understand how people value their decisions is called "delay discounting" method (Green, Fry, & Myerson, 1994; Myerson & Green, 1995), a behavioral method that measures value of behaviors based on its consequences. This method assesses the rate at which the value of a behavior decreases relative to other choices by presenting participants with choices between smaller/sooner rewards vs. larger/later rewards (Myerson & Green, 1995). Delay discounting method is shown to be useful for studying humans decision making process (Doya, 2008) making it a robust way to understand the underlying behavioral-cognitive dynamics of decision making (Matta, Gonçalves, & Bizarro, 2012).

The process that underlies delay discounting implies that when a choice is made there is an automatic attribution of values for both the choice of the immediate value and the delayed value (Matta et al., 2012). The present value of delayed rewards decreases as a function of delay interval and depending on the rate at which a reward is discounted, preferences may shift in favor of a smaller but more immediate reward (Petry, 2001). Applying this concept to our study a “greater degree of discounting” or “heavy discounting” of responding to a message means that there is an inability to wait to respond to a message later and receive a larger reward. Instead it is preferred to respond to a message now and get smaller reward which shows that texting has value. This value is called “informational value” (Atchley & Warden, 2012) and suggest that the information received through texting is valuable that people can give up a larger reward in order to access to the information sooner.

Delay discounting method can be used for understanding different aspects and dynamics of texting behavior and examining factors that influence the apparent need of younger adults to stay in constant communication via cellular phone. Texting behavior in risky situation is a decision-making process. From a decisional balance perspective there would be factors that balance our decision to respond to a text. One factor could be informational value that naturally comes with texting behavior (Atchley & Warden, 2012). Other factor is the need to stay connected through texting. Using delay discounting method for studying texting behavior of people in driving situation we can understand what factors make the information received through a message valuable (Atchley & Warden, 2012).

With respect to rewarding aspect of texting, a recent study showed that younger adults appear to discount the value of replying to a text message much more quickly than they discount money, indicating large quantitative differences in the rate at which these rewards lose value. In other words information loses its value quickly. It took almost two weeks for money ($100) to lose 25% of its value whereas the same $100 loses 25% of its value in 10 minutes when paired with opportunity to text (Atchley & Warden, 2012). This shows that texting behavior is valued because it comes with informational reward. The question that could be asked here is what other factors influence informational rewards of texting? In other words what factors have effects on rewarding nature of responding to a text message? Texting is a social activity at first place (Subrahmanyam & Greenfield, 2008) and is a way of being socially connected in younger adults (Lenhart et al., 2010). One factor that could affect informational reward of texting is the social distance (Atchley & Warden, 2012).

A recent study using delay discounting method showed that people value text messages receiving from different people differently (Atchley & Warden, 2012). In other words, the social distance of the person sending original text makes people's decision making different. People cannot wait to respond to a text message later if the message is received from their close friend or family members compared with less close friends. This shows a greater degree of discounting for the messages received form close ones. When participants were asked to consider a text from a significant other they discounted replying behavior more steeply showing that they attend to more than just the text itself (Atchley & Warden, 2012). Social distance is a factor that people use to balance their decision on either responding to a text message or not.

In addition to social distance as a factor that influences on rewarding nature of information received through a text message, we can also consider factors related to the medium of the message itself. Texting is a messaging behavior. There are different mediums a message could be delivered through including written formats such as letter, post-it note, post card, online formats such as email and technological format such as text message, instant message, voice message etc. It is possible that the medium through which a message is delivered has effects on the rewarding nature of message. If we show that people value a message received from different mediums differently then we can suggest that the medium of message is an important factor in rewarding weight of message and deciding whether to respond to a message or not. This could be another factor that make people be more willingly respond to a message that is received by text.

Using the method of delay discounting we can investigate if different informational mediums influence the way people value a message and decide to respond to that message. The primary purpose of this study is to investigate if the degree of discounting differs as people receive a message via text, in a post-it note or through a post-card. The information received through these mediums is different in immediacy and quick availability. The information received via text is more immediate and more quickly available compared to a post-it note and postcard message and the information received via a post-it note is more immediate compared to a postcard message. Since the information loses its value quickly (Atchley & Warden, 2012) the immediacy of information could have an effect of rewarding nature of it.

By offering a choice to “reply now” and receive a smaller monetary reward or “reply later” and receive a larger monetary reward over a range of delays, we can establish the delay-discounting function for the informational types of a message. Our hypothesis is that given previous work showing the value of texting, participants will discount more heavily in the text condition than the post-it note and the postcard case. Because of the possible perceived immediacy of the post-it note compared to a postcard which is sent by mail and is normally subject to a delay between sending and receiving, the post-it note condition is expected to be more heavily discounted than the postcard and discounted about the same as the text message. If this latter effect is confirmed, it may indicate that one component that makes a text message of greater value is the immediacy of the message itself compared to other mediums.

A second purpose, studied in Experiment 2, is to investigate how people value responding to a message in a driving situation. There are specific factors related to driving that could influence the way people decide to respond to a text message while driving. Some factors are related to the delivery medium of the message (cellphone vs. car in-dash system) and some others are related to the response medium of a message or the way we could respond to a message. Previous studies suggested mixed results about driver's tendency to use in-car interface systems. While some studies found that speech-based interface in cars is less cognitively demanding compared with text messaging (Lee, Caven, Haake, & Brown, 2001) some studies showed that speech-based systems could pose cognitive demands that impair driving performance (Strayer et al., 2013; Strayer & Drews, 2007). No studies have been done to see if messages via a car in-dash system are valued differently by drivers compared with those from personal cellular devices. Given the previous studies showing the value of the information received via text due to its immediacy (Atchley & Warden, 2012) we will expect that people respond differently to a message received from different sources because they value the informational reward of messages differently.

In addition to the factors that are related to the characteristics of the message delivery system there could be external factors that have effects on decision making about responding to a message. Studies suggested that on-road driving behavior is predominantly affected by the prevailing observable conditions such as weather condition (Kilpeläinen & Summala, 2007). Visibility of the road has an effect on risk perception of drivers (Abdel-Aty, Ekram, Huang, & Choi, 2011) that could affect the way they value responding to a message while driving. Studies also found that weather condition has a significant effect on cognitive processes that are necessary for driving performance such as visual attention (Konstantopoulos, Chapman, & Crundall, 2010) and eye movement (Brooks et al., 2011) as well as driving performance such as car following, speed reaction time and lateral control of vehicle (Broughton, Switzer, & Scott, 2007).

Using the delay discounting method we can investigate if the response mediums or devices through which we receive a message influence our decision to respond to the message in normal and severe weather conditions. One question is whether messages from a car in-dash system are perceived as being more or less important that those from a personal cellular device. A second question is if an increase in perceived risk due to poor weather conditions changes the way in which the importance of responding to messages is perceived and if this interacts with the medium of the message. Based on findings of previous studies on the effect of weather condition on risk perception and driving behavior of drivers we would expect that the degree of discounting for responding to a message would be higher in normal weather conditions compared to sever weather conditions. It means people cannot wait to respond to a message in normal weather conditions. In addition, it is expected that messages from personal devices will be perceived as more important, and therefore will be discounted more heavily, than those from car in-dash systems.

Experiment 1

Overview

The first experiment was designed to answer to the question that whether different informational mediums influence on the rewarding nature of a message and the way people decide to respond to a message using the delay discounting method. A message could be delivered through different mediums such as text, post-it note or post-card. The focus of this experiment is to determine discounting rate of participants' responses to a message received through different informational mediums. Different discounting rates of informational mediums reflect how much participants would be impulsive with respect to respond to a message received from different informational mediums. This is supposed to reflect a scenario that participants may encounter when driving and receiving a text message.

Participants

Forty eight (48) undergraduate students from the University of Kansas enrolled in the study for the course credit. Participants were selected using the online subject pool of the department of psychology at the University of Kansas. The sample included fifteen (15) male and thirty three (33) female subjects with the mean age of 18.91 and standard deviation of 1.28. All participants had driving licenses.

Materials

Monetary-Choice Questionnaire

The Monetary-Choice Questionnaire (K. N. Kirby, Petry, & Bickel, 1999) or temporal discounting task is a 27-item self-administered questionnaire designed to measure delay discounting rate of participant's responses to monetary choices. This questionnaire is designed for participants of 13 years of age or older. For each item, the participant chooses between a smaller, immediate monetary reward and a larger, delayed monetary reward. The protocol is scored by calculating where the respondent's answers place him/her amid reference discounting curves, where placement amid steeper curves indicates higher levels of impulsivity. A computerized version of this questionnaire was used in this study. The program presents participants with a smaller, immediate monetary reward and a larger, delayed monetary reward to choose between them.

A participant's discounting curve may be calculated according to the following function: $V = A/(1+kD)$. V is the present value of the delayed reward A at delay D, and k is the rate of discounting. k typically falls between 0.0 and 0.5, with smaller values indicating a lack of discounting and preference for delayed rewards and higher values indicating strong discounting and a preference for immediate rewards. Thus higher values of k are indicative of high levels of impulsivity (K. Kirby, 2000). This questionnaire was presented to the participants prior to the experimental task to measure participant's general discounting rate tendency.

The process that underlies delay discounting method implies that when a choice is made there is an automatic attribution of values for both the choice of the immediate value and the choice of the delayed value (Matta et al., 2012). These values are subjective and the degree of this subjective value is supposed to be associated with self-control (Petry, 2001). The present value of delayed rewards decreases as a function of delay interval and depending on the rate at which a reward is discounted, preferences may shift in favor of a smaller but more immediate reward (Petry, 2001). The inability to wait for a larger/later reward is associated with impulsive behavior, such as drug and alcohol use, gambling, smoking and other impulsive behavior disorders.

Hypothetical delay discounting task

A computerized hypothetical choice making task was used to measure participant's temporal discounting rate for each informational medium. The task was programmed to present participants with one of three hypothetical reward scenarios blocked by reward type, delay time in a counterbalanced presentation. In each scenario participants repeatedly chose between one of two rewards presented on the screen: (a) a variable smaller reward available immediately or (b) a fixed larger reward available after some variable delay. The amount of fixed larger reward was always $100 and five different delays were presented during each scenario including 1, 5, 30, 60 and 480 minutes. The indifference points or the points at which participants shift from larger reward to smaller reward are calculated based on participant's choices. The temporal discounting rate of participant's responses is calculated using the hyperbolic fit of these indifference points.

In each of three scenarios the participants were asked to imagine of receiving a message from a significant other (participants without a significant other were asked to consider being in a committed relationship when thinking about the choice) but this message could be received in term of text message, post-it note and post-card depending on the scenario presented on the screen. The participants were asked to imagine that they are driving home and it has been a while that they have not contacted anyone. As they arrive home they get a message from their significant other which reads: "contact me when you can". The received message was the same in each scenario and the only difference was in term of the medium through the message is received. Then participants were repeatedly asked to choose their preferred hypothetical rewards. The smaller reward was available immediately (11 values ranging from $5 to $95) and the fixed larger reward ($100) was available after five different delays (1, 5, 30, 60 and 480 minutes). For example participants were presented with such hypothetical choice after reading each scenario: would you rather to get $5 and reply immediately or get $100 and reply in 8 hours. The delays were chosen based on what was suggested based on younger adults opinions whom were asked to estimate short to long texting delays (Atchley & Warden, 2012).

Barratt Impulsiveness Questionnaire (BIS-11)

The Barratt Impulsiveness Questionnaire (BIS-11) (Patton, Stanford, & Barratt, 1995) is the most widely used impulsivity scale that is intended to measure the personality / behavioral construct of impulsiveness (Stanford et al., 2009). It has 30 items and scores of these items can measure impulsiveness in six first-order factors (e.g., attention, motor, self-control, cognitive complexity, perseverance, and cognitive instability impulsiveness) and three second-order factors (e.g., attentional, motor, and non-planning impulsiveness) (Patton et al., 1995). Patten et al (1995) reported the internal consistency range for BIS-11 from 0.79 to 0.83 for under-graduates, substance-abuse patients, general psychiatric patients, and prison inmates. Items are presented on a 4-point likert scale with point 1 = rarely/never, point 2 = occasionally, point 3 = often and 4 = almost always and always.

The BIS-11 which is a paper/pencil questionnaire was administrated after participants finished their computerized hypothetical choice task. We included this questionnaire in the experiment to determine possible relationship between individual differences in impulsiveness scales and participants discounting rate for each messaging scenario. Studies showed that BIS-11 questionnaire factors, specifically attentional impulsiveness factor, are associated with executive function and decision making in general population (Stanford et al., 2009). The participant's pattern of responses and discounting rate were not the same which could reflect different behavioral and cognitive impulsive patterns. This was the rational to use a questionnaire measuring impulsiveness construct in the experiment. The participants who scores higher in BIS-11 are expected to have higher discounting rate in general which could account for their higher temporal discounting.

Procedure

Participants were led into the laboratory and were asked to thoroughly read and then complete an informed consent statement and demographic questionnaire. Upon completion participants were seated at a chair in front of the computer screen. They were then orally instructed about the experiment procedure and tasks. As of first part of experiment which was computer based task, participants were seated in front of computer screen and they were asked to begin the task. They were instructed to read instructions of each scenario carefully and they were instructed that there was no right or wrong answer and to respond honestly and imagine that they are in the scenario for real.

During this phase participants were presented with full detailed instruction of what they need to do. The program was designed to present participants with the Monetary-Choice Questionnaire as the first task and then the Hypothetical delay discounting task as the second task. Before starting each scenario participants were provided with specific instruction about the scenario. The Monetary-Choice Questionnaire and Hypothetical delay discounting task took 15 minutes to complete on average. Responses and reaction times were recorded throughout the experiment and no feedback was given to participants on their performance or timing.

Upon completion of the computer based task the experimenter presented the BIS-11 questionnaire to the participants to complete which took 2-5 minutes. After completing the questionnaire participants were given a debriefing form that included information about the purpose and procedure of the experiment and contact information of experimenter. Participants were thanked and were asked to leave the laboratory and were given their credits.

Results

In the present experiment participant's temporal discounting rate for responding to a message received from different informational mediums (text message, post-it note and post card) was investigated. Figures 1 presents indifference points and the hyperbolic fit of these points for the scenarios. Area under the curve (AuC) was calculated for each set of indifference points of each scenario (See Tables 1 & 2). A one-way ANOVA on the AuC was computed and results revealed significant difference in the AuC among scenarios, $F\ (2, 141) = 4.69$, $p < 0.011$ (see Table

3). This shows that participants valued information of a message differently when the message is received through different mediums. To see which informational medium is differently valued compared with other mediums a post hoc analysis was computed. Post hoc analysis (Tukey's HSD at $p < .05$) showed that the temporal discounting rate is significantly higher for text message (average AUC= 54.47%) compared with postcard message (average AUC= 70.19%) $p <.05$ but not significant when it comes to post-it note message (average AUC= 64.89%) $p < .05$. In addition post-it scenario and post-card scenario were not significantly different.

Individual difference analysis

Participants were divided into two groups of the heavy discounters and the low discounters based on their scores on MCQ and the same analysis was done. The purpose of this analysis was to see if heavy discounters, who are more impulsive, show the same impulsiveness in responding to a message received from different informational mediums. Figures 2 shows indifference points and the hyperbolic fit of these points for the scenarios. Area under the curve (AuC) was calculated for each set of indifference points of each scenario (See Tables 4 & 5). A one-way ANOVA on the AuC was computed and results revealed significant difference in the AuC among scenarios of the heavy discounters, F (2, 69) = 4.19, $p < 0.019$ (see Table 6). Post hoc analysis (Tukey's HSD at $p < .05$) showed that the temporal discounting rate is significantly higher for text message compared with postcard message $p <.05$ but not significant when it comes to post-it note message, $p < 0.40$. In addition post-it scenario and post-card scenario were not significantly different $p < 0.49$. This shows that the participants who are more impulsive, act impulsive in responding to a text message too.

The same analysis was done for the low discounter participants. Figures 3 shows indifference points and the hyperbolic fit of these points of the scenarios for the low discounters. Area under the curve (AuC) was calculated for each set of indifference points of each scenario (See Tables 7 & 8). A one-way ANOVA on the AuC was computed and results revealed that the difference in the AuC among scenarios of the low discounters is not significant, F (2, 69) = 1.12, $p < 0.332$ (see Table 9). Post hoc analysis (Tukey's HSD at $p < .05$) showed no significant different between scenarios. This shows that the participants who are less impulsive based on their scores on the MCQ are also less impulsive in responding to a message especially text message.

Discussion

In the present experiment we were interested to see if informational medium of a messages plays a role on the way people decide to respond to the message. First, the data suggest that the informational medium of a message, or the way through which the message is delivered, has an effect on the way it is valued and people's decision to respond to a message. When people get a same message through text message, post-it note and post card, they value responding to the text message more quickly indicated by quantitative differences in the rate at which these informational mediums lose value, than for a message delivered through a postcard. In other words, people cannot wait to respond to a text message later and prefer to respond quickly. This shows that the information received through a text message is more valuable to the extent that people can ignore a larger reward in order to be able to respond to a text message. People also value responding to a text message more compared to a post-it message shown by greater degree of temporal discounting for the text message but the difference in the discounting rate is not significant. Finally they value responding to a post-it note message more than what they do for a postcard message indicated by the steeper temporal discounting rate for a post-it note message. The higher rate of discounting shows higher degree of impulsivity (Madden & Bickel, 2010).

Secondly, although the temporal discounting for responding to a text message is higher compared with post-it note and postcard messages, but it is only significantly higher from post card message. As graphs 1 shows the temporal discounting is higher for the text message and then for the post-it note message and then for the postcard message. This shows that the medium through which a message is delivered has an effect on the way the information is valued. The information received via text messages is more urgent and immediate and less urgent and immediate for the postcard messages. So it is more valued and people cannot wait to respond to a text message later. The difference in the immediacy of information is a matter of informational medium. Availability of information is different depending on the medium through which it is delivered. The information received through text messages is quickly available whereas the information received through post-it note messages and postcard messages is subject to some delay. The difference in the immediacy and availability of information is reflected in the different temporal discounting rates shown in Figure 1. So informational medium of messages has an effect on the way it is valued as well as people's decision to respond to them.

Finally, the present experiment showed that individual differences in the impulsiveness also play a role on people's decision to respond to a message. As Figures 2 shows participants who are more impulsive based on their scores on the MCQ show impulsiveness in responding to a text message too but this is not true for participants with low level of impulsiveness. Although this suggest that responding to a text message is associated with impulsiveness but the results should be interpreted cautiously. Scores on the MCQ shows impulsiveness for monetary choices but not impulsiveness in general. We need to use other scales of impulsiveness to support the notion that impulsive people are impulsive in responding to text messages too.

The present study findings complement the findings of Atchley and Warden (2012) that showed the effect of social distance on the rate of discounting. As participants were asked to consider receiving text from a significant other, the temporal discounting curves were steeper than texts from someone at an increased social distance. Here we found that in addition to social distance, the medium through which the information is delivered is also important and influence of people decisions to respond to a message. From decisional balance perspective (Velicer et al., 1985) social distance (Atchley & Warden, 2012) and informational medium of message are factors that balance people's decision's to respond to a message. In the experiment one we were interested to see how people value and decide to respond to a message in general but we are also interested to see what other factors influence people's decision to respond to a text message in driving situation. This was the starting point for running our second experiment in which we wonder if receiving a message from different devices (cell-phone vs. car in-dash system) in different weather conditions (normal vs. severe) has effects on people's decision to respond to a message in a driving situation.

Experiment 2

Overview

The second experiment was designed to determine if response medium and the perception of risk influence the decision to respond to a message in driving situations. When a message is received while driving, it could be answered through different response mediums such a cell-phone text message or car in-dash systems. A message could also be received in different weather conditions such a sunny typical day or a severe snowy day. The focus of this experiment was to investigate whether receiving messages from car in-dash systems are perceived as being more or less important that those from a personal cellular device and if an increase in perceived risk due to poor weather conditions changes the way in which the importance of responding to messages is perceived and if this interacts with the medium of the message

Participants

Fifty two (52) undergraduate students from the University of Kansas enrolled in the study for the course credit. Four participants were excluded from the study due to failure to show any effect for delay for any of the conditions, which indicated they were not attending to the experimental task. Participants were selected using the online subject pool of the department of psychology at the University of Kansas. The sample included fourteen (14) male and thirty four (34) female subjects with the mean age of 18.97 and standard deviation of 2.19. All participants had driving licenses.

Materials

Monetary-Choice Questionnaire

The description of the Monetary-Choice Questionnaire (K. N. Kirby et al., 1999) is provided in the experiment one materials.

Hypothetical delay discounting task

A computerized hypothetical choice making task was used to measure participant's temporal discounting rate for each response medium in different weather conditions. The task was programmed to present participants with one of four hypothetical reward scenarios blocked by reward type, delay time and counterbalanced. In each scenario participants repeatedly chose between one of two rewards presented on the screen: (a) a variable smaller reward available immediately or (b) a fixed larger reward available after some variable delay. The amount of fixed larger reward was always $100 and five different delays were examined during each scenario including 1, 5, 30, 60 and 480 minutes.

In each of four scenarios the participants were asked to think about receiving a message from a significant other (participants without a significant other were asked to consider being in a committed relationship when thinking about the choice). The message could be received either through a smart phone or via a car in-dash system in a normal or severe weather condition while driving depending on the scenario presented on the screen. The four scenarios included receiving a message on a smart phone when driving in a sunny normal day (scenario 1), receiving a message through car in-dash systems when driving in a sunny normal day (scenario 2), receiving a message on a smart phone when driving in a severe snowy weather condition (scenario 3), and receiving a message through car in-dash system when driving in a severe snowy weather condition (scenario 4). Here is a description of an example of one scenario: You are driving home on a long road trip in a typical sunny day. You have not been able to communicate with your significant other for several days. On your way you receive a message from your significant other appearing on your car dash screen, which reads "Contact me when you can.

Then participants were repeatedly asked to choose their preferred hypothetical rewards. The smaller reward was available immediately (11 values ranging from $5 to $95) and the fixed larger reward ($100) was available after five different delays (1, 5, 30, 60 and 480 minutes). For example participants were presented with such hypothetical choice after one trial: would you rather to get $5 and reply immediately or get $100 and reply in 8 hours. The texting delays were chosen based on what was suggested based on younger adult opinions whom were asked to estimate short to long texting delays (Atchley & Warden, 2012).

Barratt Impulsiveness Questionnaire (BIS-11)

The description of The Barratt Impulsiveness Questionnaire (BIS-11) (Patton et al., 1995) is provided in the experiment one materials.

Procedure

Participants were led into the laboratory and were ask to thoroughly read and then complete an informed consent statement and demographic questionnaire. Upon completion participants were seated at a chair in front of the computer screen. They were then orally instructed about the experiment procedure and tasks. As of first part of experiment which was computer based task, participants were seated in front of computer screen and they were asked to begin computer based task. They were instructed to read instructions of each scenario carefully and they were instructed that there is no right or wrong answer and to respond honestly and imagine that they are in the scenario for real.

During this phase participants were presented with full detailed instruction of what they need to do. The program was designed to present participants with Monetary-Choice Questionnaire as first task and then Hypothetical delay discounting task as second task. Before starting each scenario participants were provided with specific instruction about the scenario. The Monetary-Choice Questionnaire and Hypothetical delay discounting task took 15 minutes to complete on average. Responses and reaction times were recorded throughout the experiment and no feedback was given to participants on their performance or timing.

Upon completion of computer based task the experimenter presented the BIS-11 questionnaire to the participants to complete it which took 2-5 minutes. After completing the questionnaire participants were given a debriefing form that included information about the purpose and procedure of the experiment and contact information of experimenter. Participants then were thanked and were asked to leave the laboratory and were given their credits.

Results

In the second experiment the role of response medium of message while driving (cell-phone vs. car in-dash system) in different weather conditions (normal vs. severe) was investigated. Figure 4 presents indifference points and the hyperbolic fit of these points for each scenario. As figure 4 indicates there is difference among AuC of each scenario suggesting different temporal discounting rate for each scenario. Area under the curve was calculated for each set of indifference points of each scenario (See Tables 10 & 11). As table 10 shows there is difference in the percentage of AuC for each scenario. To see if there is significant difference on the AuC for different scenarios a 2 (response medium: cell-phone and in-dash car system) x 2 (weather: normal and severe) ANOVA was computed (Table 12).

The results show that there is no interaction between weather condition and response medium (F (1, 188) = 0.024, p < 0.878). However the main effect of weather condition is significant (F (1, 188) = 7.34 , p < 0.007) indicating that people are more willingly to reply to a text message in driving situation when the weather condition is normal compared with severe weather condition and this decision does not depend on whether the message is received via cell-phone or car in-dash system. Moreover, the effect of devices or response medium on people's decision to response to a text while driving was also significant (F (1, 188) = 12.64, p = 0.001). Indeed people are more likely to respond to a text message when it is received through a car in-dash system whether they are driving in a normal weather condition or in a severe weather condition.

Individual difference analysis

In the experiment two we did the same individual differences analysis to see if individual differences on the impulsiveness is associated with impulsive responding to a message. Participants were divided into two groups of the heavy discounters and the low discounters based on their scores on MCQ and the same analysis was done. Figures 5 shows indifference points and the hyperbolic fit of these points for the scenarios. AuC was calculated for each set of indifference points of each scenario (See Tables 13 & 14). A two-way ANOVA on the AuC was computed and results show that there is no interaction between weather condition and response medium (F (1, 96) = 0.41, $p < 0.521$). The main effect of weather condition was not significant neither (F (1, 96) = 2.95, $p < 0.089$). However, the effect of devices or response medium on people's decision to response to a text while driving was significant (F (1, 96) = 5.84, $p < 0.018$). Indeed people with higher level of impulsivity based on MCQ scores are more impulsive in responding to a text message when it is received through a car in-dash system whether they are driving in a normal weather condition or in a severe weather condition. Although the main effect of weather condition was not significant, we can see more impulsivity in responding to a message in different weather condition in heavy discounter participants compared to low discounter participants.

The same analysis was done for the low discounter participants. Figures 6 shows indifference points and the hyperbolic fit of these points of the scenarios for the low discounters. Area under the curve was calculated for each set of indifference points of each scenario (See Tables 16 & 17). A two-way ANOVA on the AuC was computed and results revealed that there is no interaction between weather condition and response medium (F (1, 96) = 0.017, $p < 0.898$). The main effect of weather condition was not significant neither (F (1, 96) = 0.97, $p < 0.325$). However, the effect of devices or response medium on people's decision to response to a message while driving was significant (F (1, 96) = 10.99, $p < 0.001$).

Discussion

In the first experiment we found that the informational medium of messages influences people's decision's to respond to a message. We did the second experiment to see if the device by which people receive messages while driving and the risk of the primary task of driving, modified by different weather conditions, influence the decision to respond to a text message in the driving situation. The results showed that first of all, weather condition (normal vs. severe) has effect on the way people decide to respond to a text message in a driving situation. Weather the message is received through a cellphone or a car in-dash system, people showed greater temporal discounting when the weather was normal. In other words people cannot wait to respond to a message later while driving when the weather is normal. Previous studies about the association between driving behavior and weather condition suggest that driving behavior is impaired in bad weather conditions (Abdel-Aty et al., 2011; Konstantopoulos et al., 2010; Ma & Kaber, 2005). Drivers also see driving in bad weather conditions more dangerous compared with normal weather conditions (Zhang, Huang, Roetting, Wang, & Wei, 2006). Drivers have a higher level of the risk perception about driving in the bad weather condition and this might influence on the way they value responding to a message. This could be an explanation of why people prefer to respond to a message in normal weather conditions when they are driving. Drivers cannot wait to respond to a message later in the normal weather condition whereas they prefer to wait to respond to a message later when the weather is bad. From decisional balance perspective, driving in the bad weather condition is seen as a negative aspect that has an effect on people's responding behavior to a message.

In addition to changes in perceived risk, the response medium or the way people receive a message in a driving condition influences decision making about responding to a message. Participants showed greater temporal discounting for responding to a message if the message was received through a car in-dash system rather than through a cell phone whether the message is received in normal weather condition or severe weather condition. This is an interesting finding as it was expected that participants discount the informational value of a cell phone message more as it was shown in the first experiment. There could be at least two explanations for this finding. First of all, we could say that people think that responding to a message in a driving situation will be safer if they respond to a message through a car in-dash system. Responding to a message through a car in-dash system does not require manual manipulation cellphone texting does. Responding a message by cell-phone requires phone manipulation which leads to manual distraction (Strayer & Drews, 2007). However, responding to a message using a car in-dash system requires less manual manipulation compared with cell phone use. This may lead drivers think that responding to message using car in-dash system in not necessarily an interfering task with driving performance.

A received message on the car in-dash system might be seen as part of car in-vehicle technology which is supposed to facilitate driving performance rather than threatening driver's safety. There are studies supporting the idea that in-car systems may be perceived to increase driver's safety or improve driving performance (Heejin Kim, Kwon, Heo, Lee, & Chung, 2014; Huhn Kim & Song, 2014; Takayama & Nass, 2008). Drivers also reported that they use in-vehicle technologies especially auditory in-vehicle technologies while driving showing that their attitude is not negative about using in-vehicle technologies (Kidd, McCartt, & Oesch, 2014) and even see these technologies facilitating of deriving performance (Varden & Haber, 2009; Viborg, 1999). Therefore, a received message through car in-dash system may be seen a safety-improving in-vehicle technology.

Another explanation is concerned with the immediacy and availability of the information received through a car in-dash system message. As the first experiment showed the informational value of a message is perceived higher if the information is immediate and quickly available like a text message. Considering driving situation, a received message on the car in-dash system is more quickly and easily available. Drivers see the message on their car interface system quickly available whereas the message received on a cellphone is not as easy visible as a car in-dash system message. So the information received through a car in-dash system is more immediate and thus more valuable to respond.

Finally, we can mention of the influence of advertisement of car manufacturers about advantages of in-vehicle technologies especially with respect to driver's safety. We see many advertisements in the media everyday about new cars with facilitating in-vehicle technologies and a recent survey of public opinion in the U.S, the U.K and the Australia about connected vehicles done by the University of Michigan showed that the general public in the three countries surveyed feel positive about connected vehicles, have optimistic expectations of the benefits and generally desire connected-vehicle technology when it becomes available (Schoettle & Sivak, 2014). This positive public opinion about in-vehicle technologies may explain why people prefer to respond to a message while driving using a car in-dash system.

With respect to individual differences analysis, participant's individual differences in impulsiveness based on MCQ could not differentiate between heavy and low discounters in responding to a message while driving. Both heavy and low discounter participants showed impulsiveness for responding to the messages received through a car in-dash system but not in different weather conditions. However the temporal discounting was higher for the heavy discounters regarding weather conditions although it was not significant. A possible explanation would be that the MCQ may not be an appropriate questionnaire for measuring impulsiveness. The MCQ is a valid questionnaire for measuring impulsiveness in monetary choices but may not be an appropriate scale for measuring impulsiveness in general. Using other scales of impulsiveness is suggested for measuring participant's impulsiveness.

Another justification for explaining similar results of heavy and low discounters is concerned with the role of risk perception on valuing messaging behavior. In the experiment two weather condition which is associated with risk perception was included. Manipulating the risk perception of participants may be a strong factor that influences the decision to respond a message for both heavy and low discounters. This could explain why both the heavy and low discounters cannot wait to respond to a message if the message is received through a car in-dash system.

Conclusion

The question of whether or not people, especially younger adults are addicted to cell phone use has recently received a bit of attention in the media. However, the topics and issues that have been mostly under focus are related to the frequency and quality of cell phone use by people such as how quickly the technology is used by younger adults (Amanda, Rich, Scott, & Kristen, 2010) or how accurately or inaccurately some use the technology. But less is focused on the underlying processes of decision-making of the behavior of needing to feel constantly connected (Atchley & Warden, 2012). The current study supports the notion that information has value and the decision to respond to a message is dependent on the way people value responding to a message. The first study in this area showed that the social distance of people around us has an effect on the way we value the information received through text message and our decision to respond to it (Atchley & Warden, 2012).

In our study we were interested to see what other factors influence the value of information received through a message. In other words what else causes information to increase or decrease in value? The data of experiment one argue that the decision-making process to respond to a message is influenced by the informational medium of a message. Text messages have more immediate value compared with postcard message. This is because text messages are received via a medium which is more immediate making it more urgent. So the information may lose its value if it is acquired too late. People cannot wait to respond to text message later because it loses its value. This could explain why people need to respond to a text message even when it is not the best time to do so and supports the concept of “addicted” people to their phones from the delay discounting point of view.

The results of the experiment one also showed that the way people value responding to a post-it note message compared to a text message and the postcard message compared to a post-it note message is not significant. An explanation with this respect is concerned with medium of message and immediacy of information of each informational medium. Although the information received through a post-it note message is more immediate compared to the postcard message but the difference in the immediacy of information is not too much and this may explain why temporal discounting of responding to a post-it note message is not significantly different compared with the postcard message. This is true for the text message- post-it not contrast. Although the information received through a post-it note message is less immediate compared to a text message but the difference is not too much.

In addition to the informational medium of a message that was found to influence people’s decision to respond to a message, this study also investigated some factors that could influence discounting function of responding to a message in a driving situation. Perceived risk, manipulated by differences in the weather conditions and devices by which drivers can respond to a message while driving led to differences in delay discounting rates for a text message. Drivers cannot wait to respond to a message if it is received in a normal weather condition compared to severe weather conditions. It is reasonable to value responding to a message more when weather condition is normal rather than severe because people find normal weather conditions safer.

The same pattern was observed for the response medium of a message and drivers cannot wait to respond to a message if the message is received through a car in-dash system. There are at least two explanations for this finding. First of all, we could say that people think that responding to a message in a driving situation will be safer if they respond to a message through a car in-dash system. Secondly, a received message on the car in-dash system is more quickly and easily available compared to a message received on the cellphone. Drivers see the message on their car interface system whereas the message received on a cellphone is not as easy visible as a car in-dash system message.

From decisional balance perspective (Janis & Mann, 1977) we need to consider all relevant considerations that enter into the decisional balance sheet of comparative potential gains and losses of texting while driving and see what are the “pros” and “cons” of responding to a message in a driving situation. The immediate value of text message, compared with those that have a lower perceived immediacy such as a message received via a post-card is a strong pro that can influence the decision to respond to a message. With respect to perceived risk, higher perceived risk (severe weather or using a cellular phone to manually respond to a message) would be regarded as a con factor influencing drivers to decide to delay response.

Using delay discounting method to investigate why people cannot wait to respond to message later is a robust way which has been supported in different areas. The delay discounting function of addictive behaviors is supported with recent neuroscience works. A neuroimaging study done by Laura Martin (2015) at the University of Kansas, Medical Center investigated if the delay discounting function of addictive behaviors has a reflection in the brain activity. It was shown that the dorsomedial prefrontal cortex (DMPFC) responses more when participants choose the delayed reward compared to the immediate reward. DMPFC is the brain region which suggested to be associated with executive inhibition in the behavior (Isoda & Noritake, 2013). Another brain imaging study showed that there is a relatively greater activation of the executive system in the prefrontal cortex when subjects choose the delayed reward and a greater activation of impulsive system as subjects choose the immediate reward (McClure, Laibson, Loewenstein, & Cohen, 2004). Applying this to the current study, we could say that the inability to respond to a message while driving is associated with less responsive DMPFC. This notion supports the idea of "addictive-like" or impulsiveness of texting while driving.

Finally it is notable that although we found encouraging results about underlying mechanisms of deciding whether to respond to a message or not, results should be considered cautiously. This study is the second study attempted to investigate the underlying mechanism of decision making to respond to message using the delay discounting methodology. Future studies need to replicate our findings and extend them by investigating other possible factors that could have an effect on rewarding nature of text messages. In term of future studies we would suggest to investigate other factors that can account for the variability of discounting function. A possible variable that could influences people's decision to respond to a message is "content of message". People may value responding to the text messages differently depending on the content of message. Another possible factor that may influences rewarding nature of message while driving is the type of message. For example a message could be received in term of voice message while driving and drivers may value a voice message differently.

A future avenue for research in this area is concerned with people's training to stop texting while driving. A recent study using the delay discounting methodology (Bickel, Yi, Landes, Hill,

& Baxter, 2011) found that working memory training decreases delay discounting among addicts. This is a promising research avenue for investigating how working memory training is associated with decrease in the temporal discounting. Our study was exploratory in nature that tried to find important factors that play role in people's decision to respond to a message. This study is a preparatory investigation of people's decision-making process about responding to text messages. Future studies are needed to extend findings in this area. In term of practical implication, our results suggest that texting while driving could be seen as an impulsive behavior especially when it occurs in times that are inappropriate like driving situation. However, the relationship between texting behavior and technology is complex. Future studies might complete the puzzle of addicted texting by providing more extensive understanding of motivational, cognitive and social components of decision making to cell-phone use in risky situations.

References

Abdel-Aty, M., Ekram, A.-A., Huang, H., & Choi, K. (2011). A study on crashes related to visibility obstruction due to fog and smoke. *Accident Analysis & Prevention, 43*(5), 1730-1737. doi: http://dx.doi.org/10.1016/j.aap.2011.04.003

Amanda, L., Rich, L., Scott, C., & Kristen, P. (2010). *Teens and Mobile Phones*: Washington: Pew Internet.

Atchley, P., Atwood, S., & Boulton, A. (2011). The choice to text and drive in younger drivers: Behavior may shape attitude. *Accident Analysis & Prevention, 43*(1), 134-142. doi: http://dx.doi.org/10.1016/j.aap.2010.08.003

Atchley, P., & Warden, A. C. (2012). The need of young adults to text now: Using delay discounting to assess informational choice. *Journal of Applied Research in Memory and Cognition, 1*(4), 229-234. doi: http://dx.doi.org/10.1016/j.jarmac.2012.09.001

Bickel, W. K., Yi, R., Landes, R. D., Hill, P. F., & Baxter, C. (2011). Remember the future: working memory training decreases delay discounting among stimulant addicts. *Biological Psychiatry, 69*(3), 260-265.

Brooks, J. O., Crisler, M. C., Klein, N., Goodenough, R., Beeco, R. W., Guirl, C., . . . Beck, C. (2011). Speed choice and driving performance in simulated foggy conditions. *Accident Analysis & Prevention, 43*(3), 698-705. doi: http://dx.doi.org/10.1016/j.aap.2010.10.014

Broughton, K. L. M., Switzer, F., & Scott, D. (2007). Car following decisions under three visibility conditions and two speeds tested with a driving simulator. *Accident Analysis & Prevention, 39*(1), 106-116. doi: http://dx.doi.org/10.1016/j.aap.2006.06.009

Caird, J. K., Johnston, K. A., Willness, C. R., Asbridge, M., & Steel, P. (2014). A meta-analysis of the effects of texting on driving. *Accident Analysis & Prevention, 71*(0), 311-318. doi: http://dx.doi.org/10.1016/j.aap.2014.06.005

Doya, K. (2008). Modulators of decision making. *Nature Neuroscience, 11*(4), 410-416.

Ehrenberg, A., Juckes, S., White, K. M., & Walsh, S. P. (2008). Personality and self-esteem as predictors of young people's technology use. *CyberPsychology & Behavior, 11*(6), 739-741.

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of Delayed Rewards: A Life-Span Comparison. *Psychological Science, 5*(1), 33-36. doi: 10.1111/j.1467-9280.1994.tb00610.x

Igarashi, T., Motoyoshi, T., Takai, J., & Yoshida, T. (2005). The text messaging addiction scale: Factor structure, reliability, and validity. In *Paper presented at the sixth biennial conference of the Asian Association of Social Psychology,* Wellington, New Zealand.

Isoda, M., & Noritake, A. (2013). What makes the dorsomedial frontal cortex active during reading the mental states of others? *Frontiers in Neuroscience, 7*, 232. doi: 10.3389/fnins.2013.00232

Janis, I. L., & Mann, L. (1977). *Decision making: A psychological analysis of conflict, choice, and commitment*: Free Press.

Kidd, D. G., McCartt, A. T., & Oesch, N. J. (2014). Attitudes toward seat belt use and in-vehicle technologies for encouraging belt use. *Traffic Injury Prevention, 15*(1), 10-17.

Kilpeläinen, M., & Summala, H. (2007). Effects of weather and weather forecasts on driver behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour, 10*(4), 288-299. doi: http://dx.doi.org/10.1016/j.trf.2006.11.002

Kim, H., Kwon, S., Heo, J., Lee, H., & Chung, M. K. (2014). The effect of touch-key size on the usability of In-Vehicle Information Systems and driving safety during simulated driving. *Applied Ergonomics, 45*(3), 379-388. doi: http://dx.doi.org/10.1016/j.apergo.2013.05.006

Kim, H., & Song, H. (2014). Evaluation of the safety and usability of touch gestures in operating in-vehicle information systems with visual occlusion. *Applied Ergonomics, 45*(3), 789-798. doi: http://dx.doi.org/10.1016/j.apergo.2013.10.013

Kirby, K. (2000). Instructions for inferring discount rates from choices between immediate and delayed rewards. Unpublished manuscript, Williams College.

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *Journal of Experimental Psychology: General*, *128*(1), 78.

Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J. D., & Ramsey, D. J. (2006). The impact of driver inattention on near-crash/crash risk: An analysis using the 100-car naturalistic driving study data.

Konstantopoulos, P., Chapman, P., & Crundall, D. (2010). Driver's visual attention as a function of driving experience and visibility. Using a driving simulator to explore drivers' eye movements in day, night and rain driving. *Accident Analysis & Prevention, 42*(3), 827-834. doi: http://dx.doi.org/10.1016/j.aap.2009.09.022

Lee, J. D., Caven, B., Haake, S., & Brown, T. L. (2001). Speech-based interaction with in-vehicle computers: The effect of speech-based e-mail on drivers' attention to the roadway. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 43*(4), 631-640.

Lenhart, A., Ling, R., Campbell, S., & Purcell, K. (2010). *Teens and mobile phones*. Retrieved from https://pewinternet.org/reports/2010/ teens-and-mobile-phones.aspx

Ma, R., & Kaber, D. B. (2005). Situation awareness and workload in driving while using adaptive cruise control and a cell phone. *International Journal of Industrial Ergonomics, 35*(10), 939-953.

Madden, G. J., & Bickel, W. K. (2010). *Impulsivity: The behavioral and neurological science of discounting*: American Psychological Association.

Matta, A. d., Gonçalves, F. L., & Bizarro, L. (2012). Delay discounting: concepts and measures. *Psychology & Neuroscience*, *5*(2), 135-146.

McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science*, *306,* 503-507.

Migneault, J. P., Pallonen, U. E., & Velicer, W. F. (1997). Decisional balance and stage of change for adolescent drinking. *Addictive Behaviors, 22*(3), 339-351.

Myerson, J., & Green, L. (1995). Discounting of delayed rewards: Models of individual choice. *Journal of the Experimental Analysis of Behavior, 64*(3), 263-276. doi: 10.1901/jeab.1995.64-263

O'Connor, S. S., Whitehill, J. M., King, K. M., Kernic, M. A., Boyle, L. N., Bresnahan, B. W., . . . Ebel, B. E. (2013). Compulsive cell phone use and history of motor vehicle crash. *Journal of Adolescent Health, 53*(4), 512-519.

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt impulsiveness scale. *Journal of Clinical Psychology*(51), 768-774.

Perry, S. D., & Lee, K. C. (2007). Mobile phone text messaging overuse among developing world university students. *Communication, 33*(2), 63-79.

Petry, N. M. (2001). Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. *Psychopharmacology, 154*(3), 243-250. doi: 10.1007/s002130000638

Prochaska, J. O., Velicer, W. F., Rossi, J. S., Goldstein, M. G., Marcus, B. H., Rakowski, W., . . . Rosenbloom, D. (1994). Stages of change and decisional balance for 12 problem behaviors. *Health Psychology, 13*(1), 39-46.

Schoettle, B., & Sivak, M. (2014). A Survey of Public Opinion about Connected Vehicles in the US, the UK, and Australia.

Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J. H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences, 47*(5), 385-395. doi: http://dx.doi.org/10.1016/j.paid.2009.04.008

Strayer, D. L., Cooper, J., & Drews, F. A. (2011). Profiles in cell phone-induced driver distraction. In: Fisher, D., Rizzo, M., Caird, J., Lee, J. (Eds.), *Handbook of Driving Simulation for Engineering, Medicine and Psychology*. CRC Press, Boca Raton, FL

Strayer, D. L., Cooper, J. M., & Drews, F. A. (2004). What do drivers fail to see when conversing on a cell phone? In *Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting*.

Strayer, D. L., Cooper, J. M., Turrill, J., Coleman, J., Medeiros-Ward, N., & Biondi, F. (2013). *Measuring cognitive distraction in the Automobile.* AAA foundation for Trafic Safety.

Strayer, D. L., & Drews, F. A. (2007). Cell-phone–induced driver distraction. *Current Directions in Psychological Science, 16*(3), 128-131.

Strayer, D. L., & Johnston, W. A. (2001). Driven to distraction: Dual-task studies of simulated driving and conversing on a cellular telephone. *Psychological Science, 12*(6), 462-466.

Strayer, D. L., Watson, J. M., & Drews, F. A. (2011). Cognitive Distraction While Multitasking in the Automobile. *Psychology of Learning and Motivation-Advances in Research and Theory, 54*, 29-58.

Subrahmanyam, K., & Greenfield, P. (2008). Online communication and adolescent relationships. *The Future of Children, 18*(1), 119-146.

Takayama, L., & Nass, C. (2008). Driver safety and information from afar: An experimental driving simulator study of wireless vs. in-car information services. *International Journal of Human-Computer Studies, 66*(3), 173-184. doi: http://dx.doi.org/10.1016/j.ijhcs.2006.06.005

Varden, A., & Haber, J. (2009). Driver's Attitudes Toward the Safety of In-Vehicle Navigation Systems: SAE Technical Paper.

Velicer, W. F., DiClemente, C. C., Prochaska, J. O., & Brandenburg, N. (1985). Decisional balance measure for assessing and predicting smoking status. *Journal of Personality and Social Psychology, 48*(5), 1279.

Viborg, N. (1999). *Older and younger drivers attitudes towards in-car ITS, questionnaire survey*. Lunds: Tekniska Högskola.

Zhang, W., Huang, Y.-H., Roetting, M., Wang, Y., & Wei, H. (2006). Driver's views and behaviors about safety in China: What do they NOT know about driving? *Accident Analysis & Prevention, 38*(1), 22-27.

List of Tables and Figures

Table 1: Indifference points and AuC of the three scenarios in experiment 1

Scenario	Average indifference point	AUC %
Text	73.53	54.47
Post-it	80.97	64.89
Post card	85.40	70.19

Table 2: Indifference points and AuC for the three scenarios across 5 delay points in experiment 1

Scenario	Delay (min)	Indifference Point	AUC %
Text	1	93.33	57.67
	5	87.40	57.57
	30	77.71	56.84
	60	66.50	52.65
	480	42.71	47.64
Post-it	1	95.94	68.30
	5	92.71	68.20
	30	84.17	67.41
	60	76.98	62.80
	480	55.06	57.77
Post card	1	98.23	73.77
	5	95.38	73.67
	30	90.27	72.86
	60	82.81	68.03
	480	60.31	62.62

Table 3: Analysis of Variance (ANOVA) on the AuC values of different scenarios in experiment 1

Source	SS	*df*	MS	*F*	*p*
Between group	6144.63	2	3072.31	4.69	0.011
Within-group	92370.51	141	655.11		
Total	98515.14	143			

Table 4: Indifference points and AuC of the three scenarios for the heavy discounters in experiment 1

Scenario	Average indifference point	AUC %
Text	68.83	50.97
Post-it	78.18	62.50
Post card	86.97	73.38

Table 5: Indifference points and AuC for the heavy discounters in three scenarios across 5 delay points

Scenario	Delay (min)	Indifference Point	AUC %
Text	1	88.13	54.01
	5	82.08	53.92
	30	72.50	53.25
	60	63.33	49.44
	480	38.13	44.21
Post-it	1	92.71	65.79
	5	90.21	65.70
	30	80.83	64.94
	60	75.42	60.48
	480	51.67	55.60
Post card	1	98.13	76.99
	5	96.58	76.89
	30	89.92	76.08
	60	86.25	71.22
	480	63.96	65.72

Table 6: Analysis of Variance (ANOVA) on the AUC values of different scenarios for the heavy discounters in experiment 1

Source	SS	*df*	MS	*F*	*p*
Between group	6029.34	2	3014.67	4.19	0.019
Within-group	49607.53	69	718.95		
Total	55636.88	71			

Table 7: Indifference points and AuC of the three scenarios for the low discounters in experiment 1

Scenario	Average indifference point	AUC %
Text	78.23	57.98
Post-it	83.78	67.29
Post card	83.83	67.00

Table 8: Indifference points and AuC for the low discounters in three scenarios across 5 delay points

Scenario	Delay (min)	Indifference Point	AUC %
Text	1	98.54	61.33
	5	92.71	61.22
	30	82.92	60.43
	60	69.67	55.85
	480	47.29	51.08
Post-it	1	99.17	70.80
	5	95.21	70.69
	30	87.50	69.88
	60	78.54	65.13
	480	58.46	59.94
Post card	1	98.33	70.55
	5	94.17	70.45
	30	90.63	69.64
	60	79.38	64.83
	480	56.67	59.52

Table 9: Analysis of Variance (ANOVA) on the AUC values of different scenarios for the low discounters in experiment 1

Source	SS	*df*	MS	*F*	*p*
Between group	1344.92	2	672.46	1.12	0.332
Within-group	41385.31	69	599.78		
Total	42730.24	71			

Table 10: Indifference points and AuC of the four scenarios in experiment 2

Scenario	Average indifference point	AUC %
Normal weather-Cellphone	86.67	71.57
Normal weather- Car in-dash	79.67	61.72
Severe weather-Cellphone	90.22	79.01
Severe weather- Car in-dash	83.64	67.94

Table 11: Indifference points and AuC of the four scenarios across 5 delay points in experiment 2

Scenario	Delay (min)	Indifference Point	AUC %
Normal weather-Cell phone	1	98.37	75.28
	5	97.17	75.18
	30	92.54	74.38
	60	84.67	69.33
	480	59.57	63.69
Normal weather-Car in-dash	1	96.96	65.25
	5	93.80	65.05
	30	84.57	64.08
	60	75.61	59.73
	480	47.41	54.01
Severe weather-Cell phone	1	99.20	83.12
	5	97.89	83.02
	30	92.93	82.23
	60	88.54	77.47
	480	72.54	71.19
Severe weather- Car in-dash	1	96.96	72.21
	5	94.57	72.00
	30	89.54	71.14
	60	81.09	65.49
	480	56.04	59.43

Table 12: 2 x 2 Analysis of Variance (ANOVA) on the AUC values of different scenarios in experiment 2

Source	*SS*	*df*	*MS*	*F*	*p*
F omnibus	7491.38	3	2497.12	6.18	0.001
Weather	2277.07	1	2277.07	5.64	0.019
Device	5199.69	1	5199.69	12.88	0.001
Weather*device	14.61	1	14.61	0.036	0.849
Total	83357.26	191			

Table 13: Indifference points and AuC of the four scenarios for the heavy discounters in experiment 2

Scenario	Average indifference point	AUC %
Normal weather-Cellphone	84.71	67.22
Normal weather- Car in-dash	79.41	59.60
Severe weather-Cellphone	89.93	77.36
Severe weather- Car in-dash	83.36	64.21

Table 14: Indifference points and AUC of the four scenarios across five delay points for the heavy discounters in experiment 2

Scenario	Delay (min)	Indifference Point	AUC %
Normal weather-Cell phone	1	98.13	70.83
	5	96.88	70.73
	30	92.29	69.92
	60	80.00	64.99
	480	56.25	59.61
Normal weather-Car in-dash	1	98.54	62.77
	5	95.83	62.46
	30	83.33	61.68
	60	75.33	57.43
	480	44.00	52.73
Severe weather-Cell phone	1	98.88	81.83
	5	97.71	81.73
	30	92.29	80.91
	60	87.42	75.96
	480	73.38	70.35
Severe weather- Car in-dash	1	98.96	67.81
	5	97.50	67.70
	30	90.75	66.89
	60	78.54	61.98
	480	51.04	56.69

Table 15: 2 x 2 Analysis of Variance (ANOVA) on the AUC values of different scenarios for the heavy discounters in experiment 2

Source	*SS*	*df*	*MS*	*F*	*p*
F omnibus	4079.18	3	1359.72	3.06	0.032
Weather	1307.58	1	1307.58	2.95	0.089
Device	2587.94	1	2587.94	5.84	0.018
Weather*device	183.65	1	183.65	0.41	0.521
Total	477063.13	96			

Table 16: Indifference points and AuC of the four scenarios for the low discounters in experiment 2

Scenario	Average indifference point	AUC %
Normal weather-Cellphone	87.96	73.82
Normal weather- Car in-dash	79.83	61.67
Severe weather-Cellphone	91.24	80.30
Severe weather- Car in-dash	83.95	70.90

Table 17: Indifference points and AUC of the four scenarios across five delay points for the low discounters in experiment 2

Scenario	Delay (min)	Indifference Point	AUC %
Normal weather-Cell phone	1	98.75	77.51
	5	97.71	77.40
	30	92.58	76.59
	60	89.08	71.63
	480	61.67	65.95
Normal weather-Car in-dash	1	95.63	65.09
	5	92.29	64.99
	30	86.67	64.20
	60	74.58	59.54
	480	50.00	54.51
Severe weather-Cell phone	1	99.58	84.21
	5	98.25	84.11
	30	94.17	83.32
	60	90.21	78.52
	480	74.00	71.33
Severe weather- Car in-dash	1	95.21	75.10
	5	92.08	74.80
	30	89.21	73.85
	60	82.71	68.48
	480	60.54	62.27

Table 18: Analysis of Variance (ANOVA) on the AUC values of different scenarios for the low discounters in experiment 2

Source	*SS*	*df*	*MS*	*F*	*p*
F omnibus	4900.34	3	1633.44	3.99	0.010
Weather	399.92	1	399.92	0.978	0.325
Device	4493.60	1	4493.60	10.99	0.001
Weather*device	6.81	1	6.81	0.017	0.898
Total	426238.41	96			

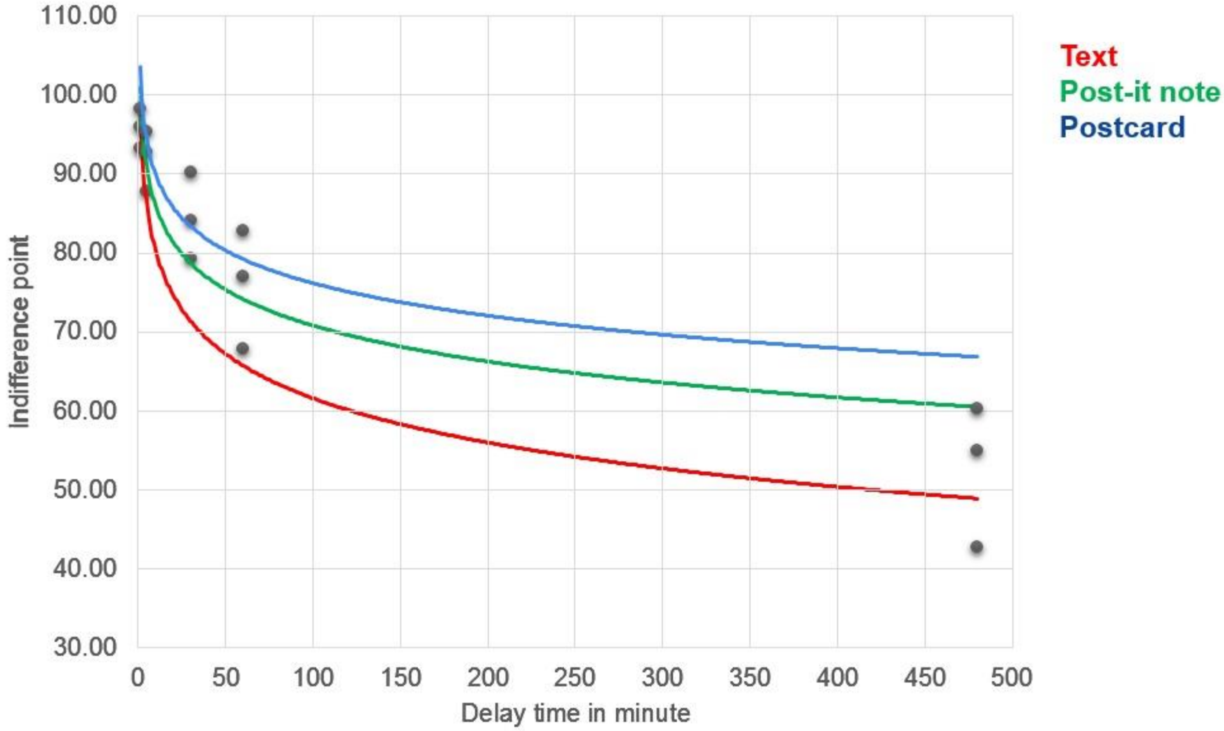

Figure 1: Mean indifference points of the scenarios across 5 delay points in experiment 1

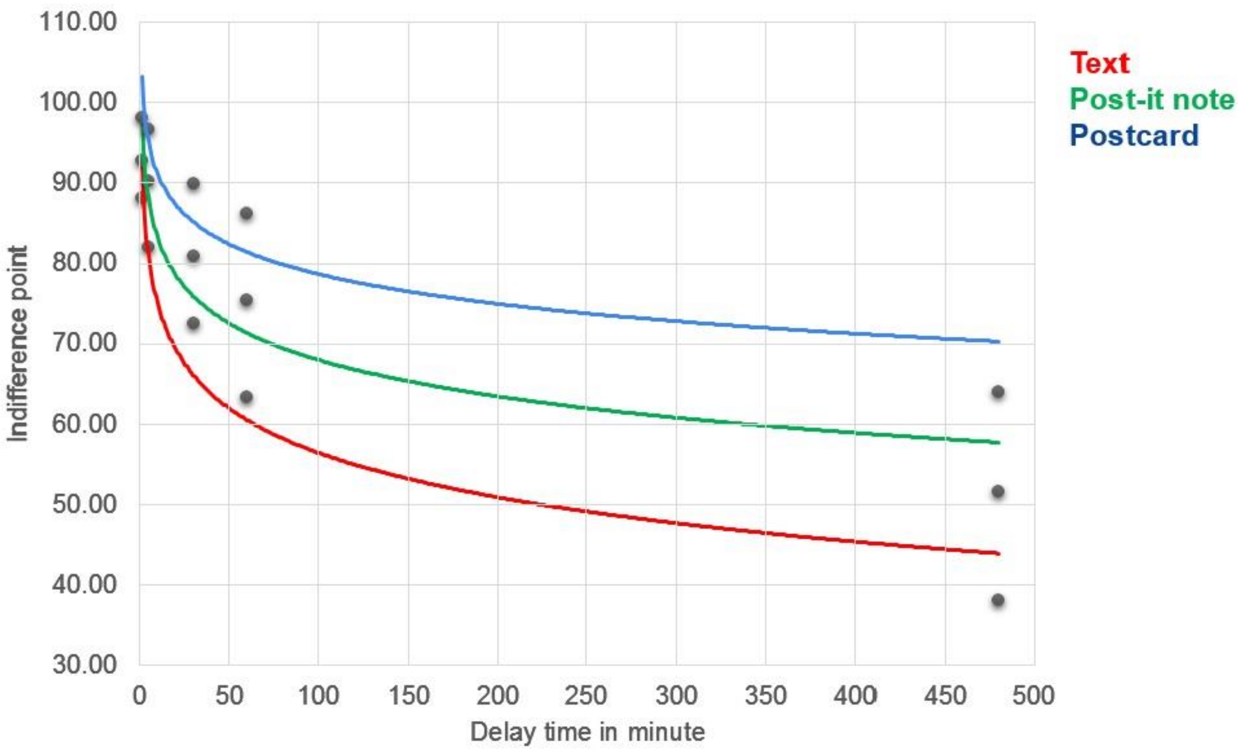

Figure 2: Mean indifference points of the scenarios across 5 delay points for the heavy discounters in experiment 1

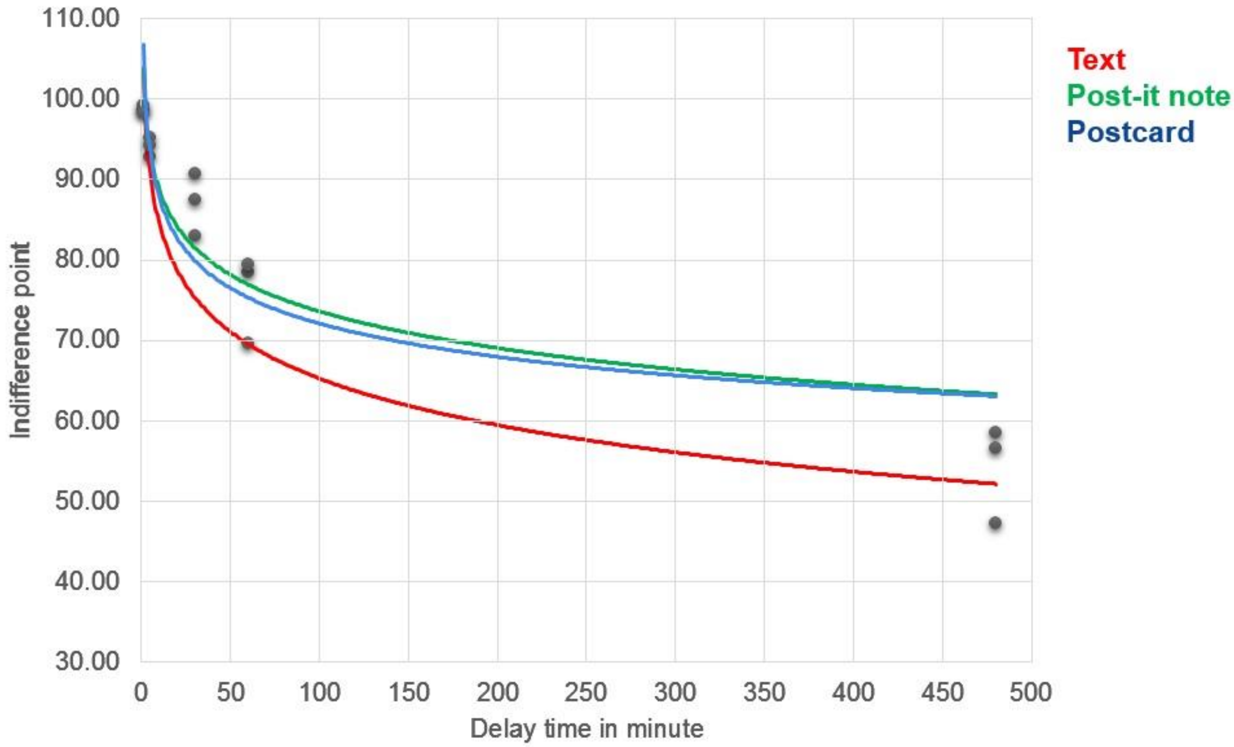

Figure 3: Mean indifference points of the scenarios across 5 delay points for the low discounters in experiment 1

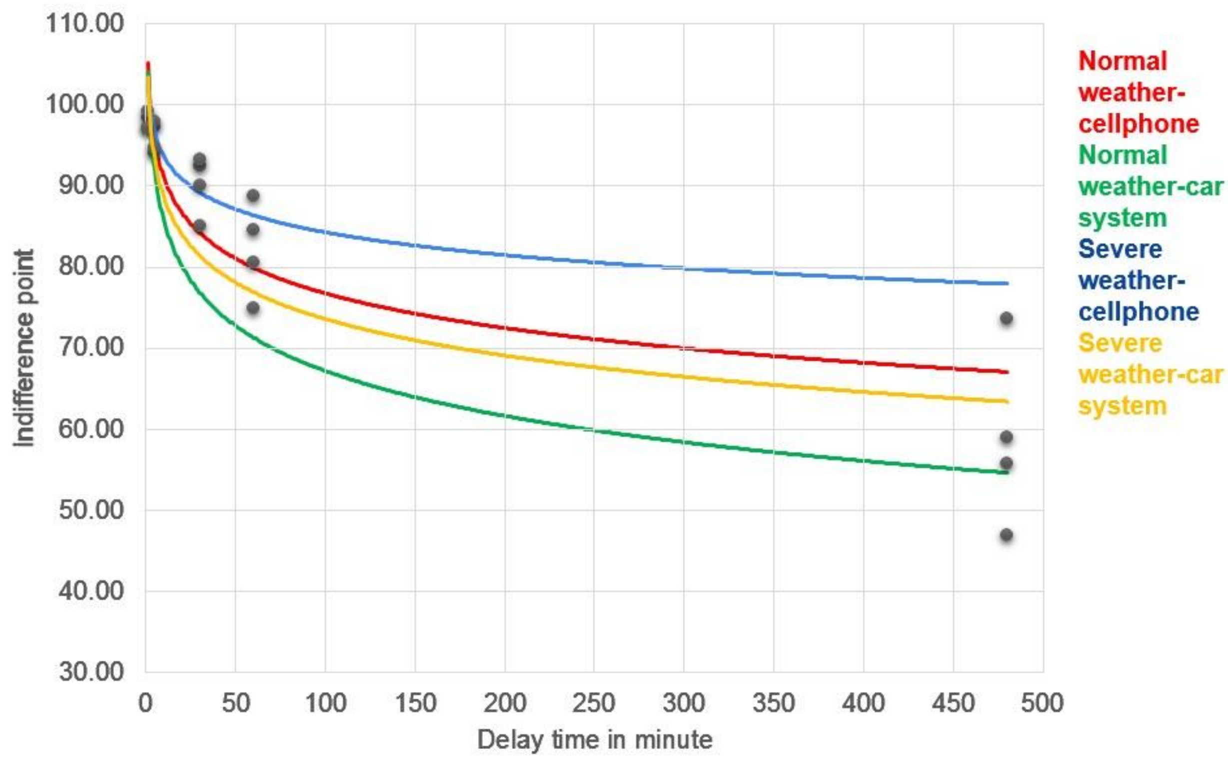

Figure 4: Mean indifference points of the scenarios across 5 delay points in experiment 2

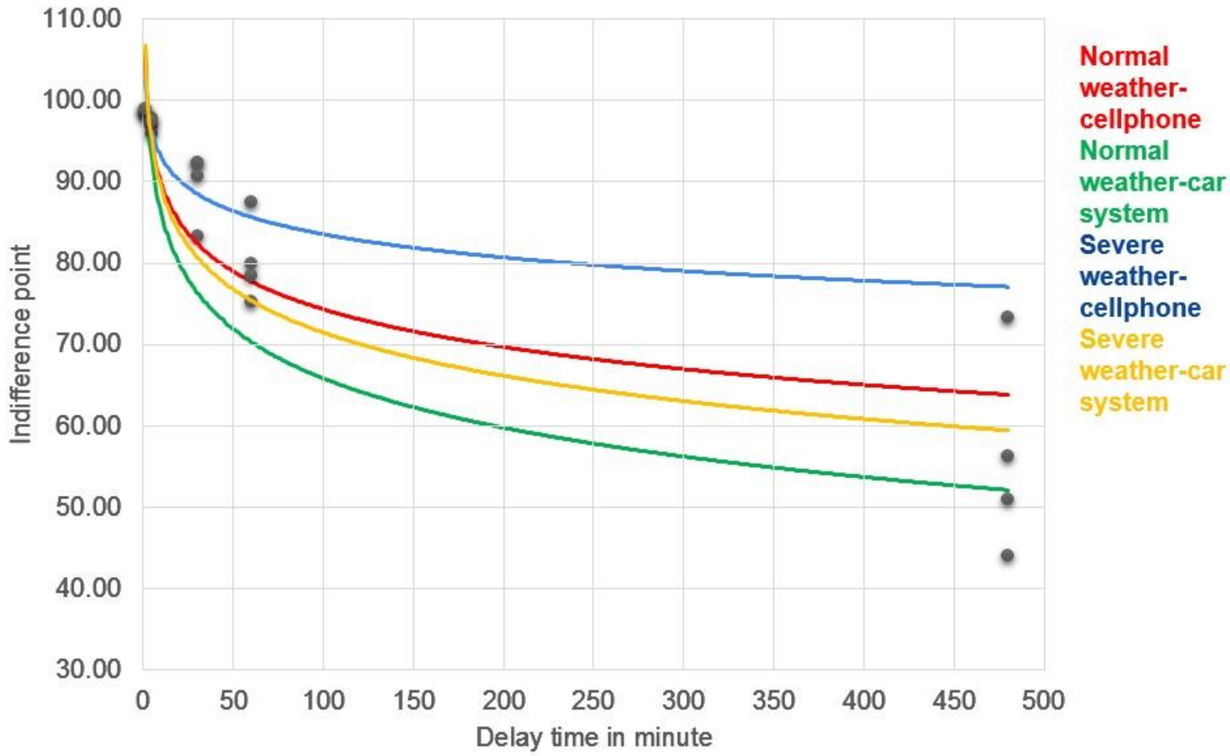

Figure 5: Mean indifference points of the scenarios across 5 delay points for the heavy discounters in experiment 2

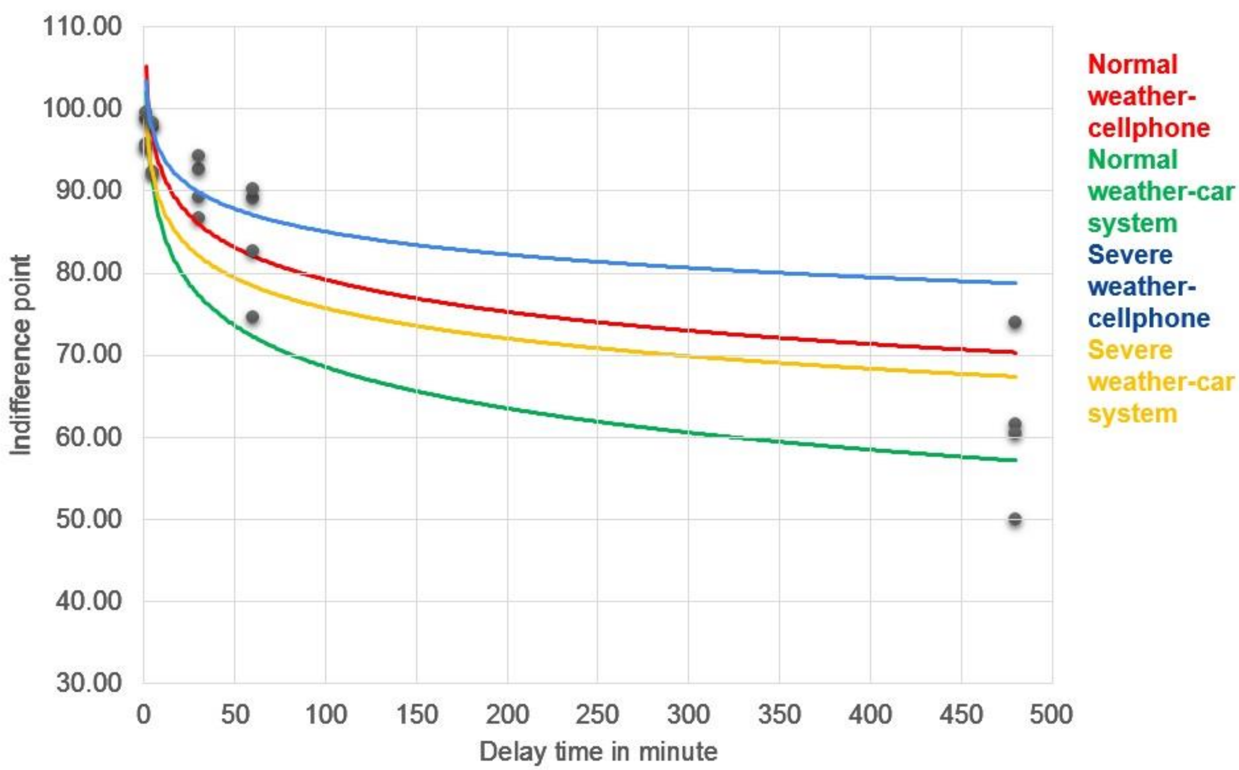

Figure 6: Mean indifference points of the scenarios across 5 delay points for the low discounters in experiment 2

Appendix A. Monetary-Choice Questionnaire

KU CENTER FOR APPLIED NEUROECONOMICS
Department of Applied Behavioral Science
Reed & Jarmolowicz, 2013
Adapted from: Kirby et al., 1999

For each of the next 27 choices, please circle which hypothetical reward you would prefer: the smaller reward today, or the larger reward in the specified number of days. While you will not actually receive the rewards, pretend you will actually be receiving the amount you indicate and answer honestly.

Would you rather have?

54 dollars today,	OR	55 dollars 117 days from now
55 dollars today,	OR	75 dollars 61 days from now
19 dollars today,	OR	25 dollars 53 days from now
31 dollars today,	OR	85 dollars 7 days from now
14 dollars today,	OR	25 dollars 19 days from now
47 dollars today,	OR	50 dollars 160 days from now
15 dollars today,	OR	35 dollars 13 days from now
25 dollars today,	OR	60 dollars 14 days from now
78 dollars today,	OR	80 dollars 162 days from now
40 dollars today,	OR	55 dollars 62 days from now

11 dollars today,	OR	30 dollars 7 days from now
67 dollars today,	OR	75 dollars 119 days from now
34 dollars today,	OR	35 dollars 186 days from now
27 dollars today,	OR	50 dollars 21 days from now
69 dollars today,	OR	85 dollars 91 days from now
49 dollars today,	OR	60 dollars 89 days from now
80 dollars today,	OR	85 dollars 157 days from now
24 dollars today,	OR	35 dollars 29 days from now
33 dollars today,	OR	80 dollars 14 days from now
28 dollars today,	OR	30 dollars 179 days from now
34 dollars today,	OR	50 dollars 30 days from now
25 dollars today,	OR	30 dollars 80 days from now
41 dollars today,	OR	75 dollars 20 days from now
54 dollars today,	OR	60 dollars 111 days from now
54 dollars today,	OR	80 dollars 30 days from now
22 dollars today,	OR	25 dollars 136 days from now
20 dollars today,	OR	55 dollars 7 days from now

Appendix B. Barrat Impulsiveness Questionnaire

DIRECTIONS: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly.

1	2	3	4
Rarely/Never	Occasionally	Often	Almost Always/Always

1	I plan tasks carefully.	1	2	3	4
2	I do things without thinking.	1	2	3	4
3	I make-up my mind quickly.	1	2	3	4
4	I am happy-go-lucky.	1	2	3	4
5	I don't "pay attention."	1	2	3	4
6	I have "racing" thoughts.	1	2	3	4
7	I plan trips well ahead of time.	1	2	3	4
8	I am self controlled.	1	2	3	4
9	I concentrate easily.	1	2	3	4
10	I save regularly.	1	2	3	4
11	I "squirm" at plays or lectures.	1	2	3	4
12	I am a careful thinker.	1	2	3	4
13	I plan for job security.	1	2	3	4
14	I say things without thinking.	1	2	3	4
15	I like to think about complex problems.	1	2	3	4
16	I change jobs.	1	2	3	4
17	I act "on impulse."	1	2	3	4
18	I get easily bored when solving thought problems.	1	2	3	4
19	I act on the spur of the moment.	1	2	3	4
20	I am a steady thinker.	1	2	3	4
21	I change residences.	1	2	3	4
22	I buy things on impulse.	1	2	3	4
23	I can only think about one thing at a time.	1	2	3	4
24	I change hobbies.	1	2	3	4
25	I spend or charge more than I earn.	1	2	3	4
26	I often have extraneous thoughts when thinking.	1	2	3	4
27	I am more interested in the present than the future.	1	2	3	4

28 I am restless at the theater or lectures.	1	2	3	4
29 I like puzzles.	1	2	3	4
30 I am future oriented.	1	2	3	4

Patton, Stanford, Barratt (1995). *J Clin Psy*, vol. 51, pp. 768-774